VIII. Issues, Goals, and Recommendations

The assessment information presented in earlier sections, along with input from the public and the combined experiences of the land management professionals working in the EOEA agencies, was used to identify a number of resource management issues and needs. Some of these are specific to the Lower Worcester Plateau ecoregion; others are statewide issues, or may apply to multiple ecoregions. A number of management goals and recommendations have also been identified from this set of issues. These goals and recommendations will help guide future management activities and planning on state-owned properties in the ecoregion. Further, it is hoped that conservation organizations, large forestland owners, and other private landowners in the ecoregion will use this document in planning management activities on their properties.

It is important to recognize that decisions about how to manage forestland, whether public or private, are based on a number of factors, including landowner values and objectives. On state lands, such decisions are often guided by legislation and agency policies. Accordingly, prior to listing the management issues, it is useful to summarize the missions and mandates for the three state divisions that manage the state lands within the Lower Worcester Plateau Ecoregion.

Massachusetts' Land Management Agencies

The 2003 reorganization of Massachusetts state government resulted in several agency name changes. In particular, the former Metropolitan District Commission (MDC) and the Department of Environmental Management (DEM) were combined to form the Department of Conservation and Recreation (DCR). Two new divisions within this department have primary responsibility for public land management: the Division of State Parks and Recreation (DSPR, which controls approximately 280,000 acres) and the Division of Water Supply Protection (DWSP, controlling approximately 103,000 acres). The former Department of Fish, Wildlife and Environmental Law Enforcement was renamed the Department of Fish and Game (DFG), within which the Division of Fisheries & Wildlife (DFW; also known as MassWildlife) controls approximately 126,000 acres statewide.

Following is an overview of the missions and mandates of these three state land management divisions.

Division of Water Supply Protection

The Division of Water Supply Protection has a mandate to "utilize and conserve…water and other natural resources in order to protect, preserve and enhance the environment of the commonwealth and assure availability of pure water for future generations" (Chapter 372 of the Acts of 1984). Within this statute, the Division is also directed to periodically prepare watershed management plans that shall provide for "forestry, water yield enhancement and recreational activities." Additional mandates are included in Chapter 737 (1972), including maintenance of the natural ecology, flora and fauna, balanced wildlife habitat and the balance of nature. It further directs that management activities shall maintain and conserve a state of natural ecological balance consistent with watershed protection purposes.

As detailed earlier, the Division of Water Supply Protection is primarily mandated to protect and provide sufficient quantities of high quality drinking water to serve the needs of 2.5 million people, approximately 40% of the population of the Commonwealth, in perpetuity. While periodic droughts have raised the issue of water quantity, the lasting focus of management is on protecting water quality. Changes in drinking water laws and regulations have significantly impacted the approach to managing naturally filtered surface supplies, including all of the DWSP supplies. The Federal Safe Drinking Water Act (SDWA) became law in 1974, and set national standards for maximum contaminant levels and treatment techniques. Amendments to the SDWA in 1986 established a priority for using filtration as a dominant treatment technique. The EPA addressed this priority through the Surface Water Treatment Rule of 1989 (SWTR), which

essentially required that all surface water supplies be filtered unless a supply could pass a rigorous test allowing it to qualify for a waiver from filtration. The SWTR established disinfection and monitoring requirements and set new limits for pathogens and turbidity, which indicate the success or failure of either artificial or natural filtration.

While the details are beyond the scope of this document, DWSP and the Massachusetts Water Resources Authority (MWRA) prevailed in a filtration lawsuit initiated by EPA, retaining permission to rely on natural filtration processes to protect water quality. The active management of forests and wildlife are considered part of a conservative approach to maintaining natural filtration, while also reducing the cost of drinking water to MWRA consumers. Wildlife has presented the greatest immediate challenge to this approach. In particular, seagulls and geese, which favor large open water bodies for roosting, transport pathogens that can threaten human health. Large scale efforts to reduce the impacts of these species have been underway for the past decade or more, and have been successful in meeting the SWTR requirements. In addition to managing these bird species, the Division turned its attention to the overabundant deer population in the forest surrounding Quabbin Reservoir during the past 15 years. Models developed within the region suggested that a catastrophic wind event could greatly impact the existing forest cover and that the absence of tree regeneration on the Quabbin watershed, as a result of high deer impacts, was incompatible with the desire to maintain predictable long-term natural filtration of the drinking water supply. Therefore, following a lengthy public process, the Division began managing the deer population in 1991, and has restored the ability of the forest to regenerate as a result.

In addition to managing wildlife, Land Management Plans for each watershed establish goals for diversifying both age and species structure of the forest cover. Objectives for meeting these goals call for maintaining an understory as the “reserve” or future forest; a midstory for its rapid nutrient uptake; and an overstory for its regulation of organic decomposition, its provision of seed, and the water infiltration and retention function of its deep root system. These canopy layers are to be balanced, using primarily a small-group selection system of uneven-aged silviculture and an irregular shelterwood system of even-aged silviculture, throughout the managed forests. The working hypothesis of this approach is that frequent disturbances of the scale of small group selection silviculture will lessen the amplitude of infrequent but catastrophic large-scale disturbances. In setting this approach in motion, DWSP also made a commitment that any short-term negative effects of silviculture would not exceed the long-term benefits to drinking water derived from this deliberate forest structuring. While there has been no decline in raw water quality during the past forty years of active management of these forests, a more intensive monitoring effort has begun recently that is designed to quantify the effects of incorporating more deliberate restructuring of the forest cover into the protection of unfiltered surface supplies of drinking water.

In addition to these focused efforts to address drinking water quality through natural resources management, DWSP management affects the protection and production of habitats for both common and rare wildlife, the conservation of biological diversity, the recreational uses of DWSP properties, landscape aesthetics on many scales, and the local economy. These secondary objectives are addressed in Land Management Plans, Watershed Protection Plans, and Public Access Management Plans for the watersheds. Further treatment of these objectives is also a component of the initial and subsequent annual audits of DWSP properties for "green" certification. In 1997, Quabbin became the first public land in North America to be certified by the Forest Stewardship Council for sustainable management, and the remaining DWSP properties have been recently audited for certification, as discussed at the beginning of this document.

Division of State Parks and Recreation

The Division of State Parks and Recreation is dedicated to improving the quality of life in the Commonwealth of Massachusetts by conserving our natural and cultural resources through professional stewardship, connecting people to these resources through recreation and education, and cooperating and partnering with others who share this common purpose. DSPR is the steward

of about 280,000 acres of the state's forests, beaches, mountains, ponds, trails, and parks. The DSPR protects land and resources on privately and municipally held land through technical assistance, grant programs, planning programs, policy development and other resource protection services. The Division's stewardship of natural and cultural resources provides significant benefits to the Commonwealth and its citizens including: clean water, open space, wildlife, habitat, timber, environmental education, and opportunities for outdoor recreation and renewal. The powers and responsibilities for DSPR are set forth in M.G.L. Chapters 21, 132, and 132A.

The DSPR's Bureau of Forestry exists to protect the public's interest in the both the private and public forestlands of Massachusetts. These public interests include: water conservation, flood and soil loss prevention, wildlife habitat, recreation, protection of water and air quality, and a continued and increasing supply of forest products. The enabling legislation that created the Bureau of Forestry states that the State Forests shall be "in perpetuity income producing." This same legislation also states that the Bureau shall manage to "improve" these same forests. It is this balance that is at the heart of the Bureau and its social responsibility. More specifically, Massachusetts General Law Chapter 132 defines the mission of the Bureau.

The Bureau meets its responsibility through the careful, thoughtful consideration of ecological, social, and economic factors. All resources are considered and managed for in a holistic, integrated manner. Well-defined desired conditions are established for each resource, and management objectives and guidelines are described to meet the needs of each.

The Bureau of Forestry fulfills its mission by first providing for native healthy ecosystems, rare landscape features and species, water quality, site and forest productivity, and aesthetics. Given these factors, state forests are managed to provide a variety of forest conditions ranging from open-lands to very old late-successional forests to provide a range of habitats and forest conditions to meet ecological, social, and economic considerations. The Bureau accomplishes these objectives by designing and implementing silvicultural systems. The Bureau strives to provide high quality forest products in a sustainable, environmentally and socially responsible manner

Division of Fisheries and Wildlife

The Massachusetts Division of Fisheries and Wildlife's (DFW) statutory responsibility provides for the conservation (including protection, restoration, and management) of Massachusetts' flora and fauna (Darey and Jones, 1997). Species of flora and fauna rarely exist in isolation, but rather occur in assemblages, or natural communities. In turn, each natural community dynamic is driven by ecosystem processes, such as natural disturbances, nutrient cycling and energy flow. This interaction between the complex of species, natural communities, and ecosystem processes represents DFW's working definition of biological diversity, or 'biodiversity'.

DFW maintains that it is possible and desirable to accommodate a variety of cultural demands on the 120,000 acres of state wildlife lands, including traditional uses such as non-motorized public recreation and production of renewable wood products. However, the degree to which cultural activities are appropriate on DFW forestland must be determined by the agencies' ability to meet its goal of biodiversity conservation. Biological inventories combined with subsequent biological monitoring of species and communities on both actively managed lands (e.g., where harvest of wood products occurs), and on passively managed lands (e.g. forest reserves) will be used to verify that DFW is meeting its biodiversity conservation goal.

Forest management policy should recognize the role that natural disturbance processes play in the maintenance of biodiversity (DeGraaf and Miller, 1996). Preserving biodiversity in temperate forest regions requires maintenance of all seral stages, including the creation of early-seral habitats and the preservation or re-creation of late-seral or old-growth forests (Franklin, 1988). Therefore, in order to maintain biodiversity, the management of DFW forestland requires the designation of some natural ecosystems as forest reserves (areas that are not subject to wood products extraction) as well

as commodity production in modified, semi-natural (managed) ecosystems (Hunter, 1996; Irland, 1999). Successful strategies for conservation of biological diversity in temperate forest regions must effectively address the designation of networks of reserves as well as a managed forest matrix (Lindenmayer and Franklin, 1997).

Forest management on DFW lands includes both active silviculture to create and maintain structurally diverse forests, including early successional forest habitat, as well as passive management, primarily including the establishment of a system of forest reserves that will eventually develop late successional forest habitat values, function and structure. General landscape composition goals for DFW forestland presently include 15% early-seral forest (seedling/sapling and small pole), 70% mid-seral forest (large pole and sawtimber), and 15% late-seral forest (forest reserves). At the conclusion of the on-going EOEA forest reserve planning process described elsewhere in this document, the final percentage of forest reserve area on DFW lands may exceed 15%, and could potentially exceed 20%. The final amount of reserve lands will be determined by what is needed to meet goals established for reserves.

To accomplish its landscape composition goals, DFW would need to treat about 1,500 acres annually using a combination of modified even-aged silviculture on a 100 year rotation, and uneven-aged silviculture on a 120 year rotation. These anticipated silvicultural treatments would generate approximately six million board feet (MMBF) of timber annually from publicly-bid sales on actively managed forestland (due to on-going staffing limitations and a current focus on inventory and planning, DFW presently treats <200 acres annually, and generates <1 MMBF of timber from publicly-bid sales). DFW will update existing forest inventory data during calendar year 2004 to refine current harvest projections.

Ecoregions serve as the fundamental planning unit for all forest management decisions, and within an ecoregion DFW properties are grouped into individual management units that are defined by portions of major watersheds within the ecoregion. Following the guidance provided in the ecoregion documents, management unit plans are drafted for various DFW properties that merge individual site plans that had previously been drafted on a property by property basis. All planned silvicultural treatments described within a management unit plan are reviewed internally by the Natural Heritage section and by the appropriate regional DFW District office. After internal review is completed, a Chapter 132 forest cutting plan is submitted to DCR, and a timber sale contract is completed through a public bidding process.

Silvicultural treatments on DFW forestland create extensive, structurally diverse stands across a range of seral forest stages. DFW land managers attempt to incorporate elements of natural disturbance patterns into managed forestland by extending conventional rotation lengths, increasing stand size, retaining clusters of mature trees, and fostering heterogeneity of tree species, tree quality, and tree size classes. Biological monitoring activities are conducted before and after the implementation of management activities at selected sites. This information can be used to modify future prescriptions.

The missions of all three of the above divisions also include, to varying degrees, technical assistance, education and regulation of activities on private forestland. Of the three, the DSPR is most active on private forestlands. Accordingly, goals and objectives for technical assistance, education and other state programs directed at non-state forestland will also be presented in this section. It should also be noted that the support of municipalities, conservation organizations and private landowners will be extremely important in order to increase the chances of successfully implementing management goals and objectives across the whole ecoregion.

Specific Issues, Goals, and Recommendations for Action

Following are the main ecological or management issues identified for the Lower Worcester Plateau ecoregion, arranged by the same categories used in the earlier assessment sections. It should be noted that the numbering of these issues does not imply a ranking of priorities.

Conservation of Biological Diversity

Issue 1: Historic land use has left behind predominantly mid-seral stage forests in this region. Consequently, there are relatively few contiguous blocks of both older and younger forests in the ecoregion today. These early and late forest seral stages provide habitat features on which many species depend; thus, their limited occurrence limits regional biodiversity. While coordinated active management on state lands can enhance and expand these types of habitat, better education and incentives are also needed to address this need beyond state ownerships.

Goal: Enhance and expand the occurrence of contiguous blocks of early and late successional habitats within the Ecoregion.

Recommendations:

- Evaluate existing conditions, and adopt appropriate habitat goals on state properties to diversify wildlife habitat conditions in the ecoregion.
- Manage contiguous older forest blocks (100+ years) on state land either on an extended rotation (150+ years) or as reserves.
- Seek opportunities to manage and consolidate large blocks of early seral habitats.
- Seek opportunities to provide contiguous and concentrated large blocks of reserves and areas of extended rotations.
- Design reserves and areas of extended rotations to provide for biodiversity and protection of habitat and rare species. These areas should also consider impacts to recreational opportunities and water resources in their development, thereby meeting multiple resource objectives.
- Coordinate with state, federal, and local governments and private landowners to assist with reserve and large block identification and management.
- Target technical, financial, and educational assistance to private forests that complement state practices to enhance early and late seral habitats, especially in areas where regional biodiversity would be enhanced by blocks of early or late seral forests.

Issue 2: There is currently no coordinated approach to creating and maintaining a system of forest reserves in the state. Such a system would provide multiple benefits, including: providing ecological reference conditions; creating or maintaining under-represented ecological conditions; protecting viable habitats or other features that are sensitive, rare or unique in the landscape and least likely to be maintained within managed forests; providing baseline scientific conditions or features for research, or to instruct forest management; and providing unique recreational and spiritual values for the citizens of the Commonwealth. The designation of forest reserves is a potentially controversial topic that must incorporate a number of ecological and social factors. Therefore, there needs to be an appropriate process for reserve identification, establishment and maintenance.

Goal: Establish a network of forest reserves in the LWP Ecoregion that provides a wide range of ecological and social benefits.

Recommendations:

- Initiate a process for establishing a network of forest reserves in Massachusetts that strives to enhance the above benefits.
- Develop an objective scientific methodology for identifying potential small and large patch forest reserve areas on EOEA lands in Massachusetts with consideration of existing work by TNC and public input.
- Evaluate existing TNC work to help identify potential large "matrix" forest reserves, encompassing both public and private lands, in one or more portions of the state. Evaluate opportunities for large reserves using a collaborative, public-private partnership approach, with opportunities for public input.
- Establish forest reserves on approximately 15% of state-owned lands in the LWP through a collaborative effort using GIS and other tools in conjunction with the local knowledge of land managers and other experts. Address any logistical or managerial constraints related to agency missions or mandates.
- Include opportunities for public input into the identification, establishment and maintenance of a forest reserve system, including the posting of draft maps and methodologies on the EOEA website.

Issue 3: Unprotected forests in the region are being fragmented by development. Concurrent impacts include loss of habitat viability and shrinkage in average ownership parcel size. These impacts reduce the economic viability of forest management. Even though the forest within the ecoregion still has large blocks of unfragmented habitat, studies show that even small amounts of scattered development are causing significant reductions in these forest blocks. A study by Harvard Forest, for example, found that in one recent 15 year period, the average unfragmented forest block in the region north of Quabbin Reservoir declined from 1,100 to 800 acres due to scattered housing development.

Goal: Focus protection efforts on protecting the largest, most intact and threatened forest blocks in the ecoregion.

Recommendations:

- Target limited state, federal, municipal and private land conservation funding and efforts to purchase or otherwise protect large, intact, forested parcels.
- Educate landowners about the benefits of gifts or bargain sales for conservation, and work in partnership to protect high conservation value parcels.
- Identify lands in the SLCP that are located along the "sprawl front" or other portions of the LWP ecoregion threatened by fragmentation, and prioritize these lands for protection.

Issue 4: A number of "BioCore" areas, Priority Habitats, Living Waters "Core Habitats," vernal pools, and other special habitats have been identified in this ecoregion. Many of these sensitive sites occur on private, unprotected land. The features and values associated with these fragile resources may be threatened by the sprawl development occurring with increasing frequency within or adjacent to the ecoregion.

Goal: Protect rare habitats on state lands, and target state, municipal, and other land conservation resources on protecting uncommon or rare species habitats on private lands.

Recommendations:

- Incorporate appropriate inventory and protection measures for rare or sensitive habitats into individual state property management plans.
- Treat all vernal pools on state lands as if they were "certified," and adopt the protective measures developed by the DWSP on all stand lands.
- Target limited state, federal, municipal and private land conservation funding and efforts to purchase or otherwise protect high conservation value parcels that have been identified by the BioMap or Living Waters programs.
- Educate landowners about the benefits of gifts or bargain sales for conservation and, in partnership, protect key parcels with high habitat value.
- Consult when necessary with the NHESP on the management of rare habitats on both public and private forestlands.

Forest Conditions, Health, and Productivity

Issue 5: The large, contiguous blocks of oak forest in this ecoregion are of exceptional wildlife and economic value. These oak forests are under pressure from pests such as the gypsy moth, fragmentation by development, and short-term liquidation of their valuable timber. Furthermore, regenerating these forests requires more careful, deliberate silviculture than is required to regenerate other forest types in this ecoregion. This type of silviculture is difficult to implement consistently throughout the ecoregion.

Goal: Maintain and enhance the oak forest across the ecoregion, especially the early and late seral oak habitats.

Recommendations:

- Increase education and training of licensed foresters in the regeneration of oak forests.
- Coordinate public-private efforts to expand demonstration forests that show a variety of successful oak regeneration techniques.
- Target technical assistance (e.g., state and federal cost share programs) to furthering best silvicultural practices for oak regeneration.
- Encourage the maintenance and enhancement of older oak forests on private lands.
- Maintain a component of older oak forest on state forestlands.

Issue 6: High-grading in the ecoregion's forest is causing the degradation of economic and ecological values of some of our most valuable forests. Inadequate recognition of the economic value of long-term stewardship, combined with poor markets for low quality products have led to heavier cutting of higher-value species and higher-quality trees in the region. The overall result is a trend toward lower per acre value and quality of the region's forests. High-grading also can short-change landowners, as high quality trees are often harvested just at the age when they quickly add growth and value and provide the most benefit for wildlife. High-grading also removes high quality seed trees before regeneration cuts occur.

Goal: Minimize high-grading within the Commonwealth by encouraging the application of sustainable forest management and conservation biology principles to meet landowner objectives.

Recommendations:

- Implement a new Forest Cutting Plan process that identifies cutting proposals considered to be high-grading, and requires that the landowner sign an acknowledgement of this fact.
- Monitor the extent of high-grading over the first year of this program change and take further action, if necessary to reduce the practice.
- Send the new "Woodlot Owners Guide," which includes a detailed explanation of the environmental and economic benefits of long-term forest stewardship and the problems with high-grading, to the owners of 500,000+ acres of the state's private forestland over the next two years.
- Provide educational opportunities for private landowners on the problems with high-grading and the environmental and economic benefits of long-term forest management.
- Post an article on the Department of Conservation and Recreation web site outlining the problems and solutions for high-grading.
- Cooperatively work with industry, state agencies, research universities, consulting foresters and technical institutes to develop new technologies and promote existing industries that utilize low quality forest resources.
- Seek grants to establish and promote industries that utilize low quality forest resources.
- Seek opportunities to utilize and market forest products that are derived from low quality forest resources.
- Make state-owned forestland models of sound silvicultural practices and sustainable forest planning.
- Work with private consulting foresters to seek their cooperation and ideas on minimizing high-grading.
- Provide multiple incentives for offering forest management expertise to private forest landowners.
- Provide opportunities to work with harvesters and primary manufacturers to promote sustainability (including various Forest Certification systems) of natural resources.
- Convene a forest forum in the spring of 2004 with diverse representation from all parts of the forestry community, including consulting foresters. One of the goals of the conference will be to explore ideas and develop actions that address the high-grading issue.

Issue 7: "Restoration forestry" should be used as needed on state lands and encouraged on private lands. This type of forestry helps to restore the ecological structure of our forests to a condition closer to that found prior to European settlement.

Goal: Restore degraded forests (e.g., formerly extensively high-graded stands, plantations, etc.) to a more natural and native condition.

Recommendations:

- Manage for larger, more heterogeneous forest stands, limit whole tree chipping, and set policies to allow for adequate coarse woody debris after logging by including these objectives in state lands management plans.
- Encourage licensed foresters to incorporate this approach in forest management plans prepared for private forestlands.
- Restore previously high-graded stands through silvicultural systems that promote suitable ecological conditions (i.e., natural forests, snags, legacy trees, coarse woody debris, etc.).

Issue 8: Non-native, invasive plant species are present throughout the LWP ecoregion. Once established, these species can aggressively spread across landscapes, often following deliberate

or natural disturbances, but also within undisturbed woodlands. Their dominance threatens species diversity on a local scale by preventing or overwhelming the regeneration of native plants, including tree species. Rare plant species populations are particularly vulnerable to the spread of invasives, as their populations tend to be small and sensitive to change. For example, DCR staff recently worked to remove an aggressive Asiatic bittersweet (*Celastrus orbiculatus*) infestation from a talus slope within the unmanaged Pottapaug Pond Natural Area at Quabbin Reservoir because it threatened to overwhelm an adjacent population of the state-listed Maple-leaf goosefoot (*Chenepodium simplex*). While many invasive plant species are already well-established within the state and this ecoregion, others are in nearby regions but have not yet established themselves here. It is extremely difficult to eradicate established populations, but relatively easy to prevent the spread of new arrivals in the earliest stages of establishment.

Goal: Prevent new occurrences of non-native, invasive plant species and identify and control existing invasive threats to rare plant populations.

Recommendations:

- Support efforts by the New England Plant Conservation Program, the New England Wild Flower Society, the Natural Heritage and Endangered Species Program, and other state agencies to discover, inventory, map, and monitor rare plant populations.
- Support efforts by the Invasive Plants Atlas of New England (IPANE) and state agencies to map and monitor plant populations determined to be "invasive" and "potentially invasive" by the Massachusetts Invasive Plants Working Group.
- Model potential interfaces between rare plant populations and expanding invasive plants, and maintain a "no invasives" buffer around rare plant populations of concern.
- Develop a rapid alert system for the arrival of new invasions, and work with IPANE and others to deploy a rapid response system to eradicate new invasions as they are discovered and before they spread beyond control.

Issue 9: Hemlock woolly adelgid (HWA) has arrived in the ecoregion and threatens the majority of its hemlock forests. State agencies and private organizations are working to develop and implement strategies for responding to this pest, but difficult issues remain in predicting the pace of hemlock mortality, identifying effective and affordable biological or chemical controls, anticipating changes in regional markets for salvaged hemlock, and replacing habitat values lost through hemlock mortality.

Goal: Minimize the impact of hemlock wooly adelgid (HWA) on the forest within the ecoregion.

Recommendations:

- Develop HWA action plans for state forestlands that include a diverse array of actions across the various hemlock stands within the ecoregion. Actions may include:
  - Establishing mixed species of regeneration through silvicultural thinning and enrichment planting while the overstory is still healthy, to assure a diverse replacement forest when and if hemlock woolly adelgid kills the remaining overstory;
  - Conducting salvage harvests at pre-defined stages of infestation (e.g. when 50% of the overstory is infected with hemlock woolly adelgid) for properties on which timber value is a primary objective or where dying hemlocks present a hazard to recreational users;

- Intensive stand protection, without cutting, through application of biological and chemical controls for a few stands of particularly high wildlife, ecological or social value;
- No action, when the potential risks associated with intervention are considered greater than those associated with HWA-associated mortality, for instance in riparian filter strips adjacent to surface drinking water supplies.

- Partner with others to educate and coordinate responses to HWA.
- Monitor the results of various actions to improve future response.

Soil and Water Conservation

Issue 10: Collectively, the forests of this region protect and provide drinking water for close to 50% of the population of Massachusetts, with surface water reservoirs being the primary sources. The cost to maintain the quality of these water sources would greatly escalate without the protective function of forest cover. This value needs to be better accounted for in support of conserving these watershed protection forests. The protection of forestlands should be increased to ensure that future water quality objectives can be achieved.

Goal: Enhance the protection of the ecoregion's water supplies via improved land conservation and forest management.

Recommendations:

- Evaluate the possibility of expanding land conservation on watersheds that provide drinking water to the Massachusetts Water Resources Authority (MWRA) by taking these capital expenditures off the state bond "cap" because all debt service is fully reimbursed by the MWRA.
- Partner with others to submit a multi-owner Forest Legacy application within the ecoregion's Forest Legacy Areas that includes water supply protection values of forestland.
- Continue to offer private landowners within the ecoregion incentives to join the Forest Stewardship Program, especially those on drinking water supply watersheds.
- Coordinate state forest management activities on drinking water watersheds to assure that water quality protection is a primary management objective.
- Evaluate the role of road construction and maintenance activities related to forest management operations as a possible source of water quality degradation near public drinking water supplies.

Issue 11: Unregulated or inadequately patrolled motorized vehicle (ORV/ATV) use on forestlands has resulted in increased soil erosion, water quality degradation and other impacts to the forest resources of this ecoregion.

Goal: Reduce damage resulting from ORV/ATV activity within the ecoregion.

Recommendations:

- Develop agreements with local police departments in key impact areas to improve enforcement of existing regulations.
- Implement education programs to user groups and retailers regarding use of ORV/ATVs on public, non-profit and private forestlands.
- Evaluate ORV/ATV use and impacts on state lands as part of the management planning process for specific properties.

Regional and Global Considerations

Issue 12: The region consumes large quantities of energy, and could sustainably produce large quantities of "green certified" biomass. Increasing reliance on this local, renewable and carbon-neutral energy source could enhance forest protection and management and benefit the rural economy while reducing the region's dependence upon imported energy.

Goal: Utilize existing state and federal renewable energy programs to fund a significant biomass application within the ecoregion.

Recommendations:

- Submit applications to renewable energy grant programs to support funding of a feasibility study for the design and construction of additional biomass facilities within the ecoregion.
- Support the work being carried out at the Forest & Wood Products Institute at Mount Wachusett Community College regarding the development and increased use and affordability of biomass and related renewable energy resources.

Socio-Economic Factors

Issue 13: Chapter 61, the forest tax law, has enrolled approximately 350,000 acres, or about 15% of the state's private forestland. The percentage of land in the program has not significantly increased for some time. Changes have been suggested to make Chapter 61 more inviting to new enrollees.

Goal: Increase the amount of land enrolled in programs like Chapter 61 and the Forest Stewardship Program that provide significant incentives for private landowners to keep their land in forest cover.

Recommendations:

- Convene a forestry forum in the spring of 2004 with a diverse participation. One goal of this forum will be to increase the amount of land enrolled in Chapter 61.
- Continue to offer targeted forest landowners a state-funded Forest Stewardship Plan as an incentive to join that program. Approximately 80% of participants in this program also enroll in Chapter 61. The goal of the current effort is to add 30,000 acres to the Stewardship Program by July, 2004.

Issue 14: Rural communities with a significant percentage of state lands are very concerned that their payments in lieu of taxes (PILOT) do not adequately pay for the cost of having these state-owned lands within their communities. Costs for activities such as forest fire fighting, search and rescue, and law enforcement often exceed the PILOT. Historically, rural communities received a similar per acre PILOT as suburban communities until the law was changed to assess open space land based on its fair market value for development. This change shifted the bulk of PILOT payments to suburban towns.

Goal: Provide more equitable compensation to rural municipalities for the costs of having state-owned lands within their communities.

Recommendations:

- Convene a panel of balanced represented interests to review the current PILOT system. Propose approaches and alternative methods that adequately and equitably

compensate local communities for the loss of property tax revenues from state forestland.

- Advocate for assessing the value of open space land based on its forest, water supply and recreational value. This would help to equalize PILOT payments across the Commonwealth.
- Advocate for more widespread support for legislation that will add a 20% surcharge to DCR facilities with 50% of this income going to the host community and 50% shared equitably by all PILOT communities.
- Advocate for more widespread support for legislation that will dedicate a larger portion of DSPR timber revenues to the towns in which the revenue is generated.
- Fully implement sustainable, Green Certified forest management plans for all state ownerships over the next 10 years, thereby increasing the amount of payments to local communities with DSPR land.

Issue 15: The operational, infrastructural and other economic aspects of the forest product industry in this region are such that many of the forest resources harvested in this area are exported to other states or countries, with little or no local processing. This results in the loss of significant employment and value-added economic opportunities for the region. Further, state bidding requirements result in logging contracts being awarded to the highest bidders, thereby causing a lack of continuity in forest management, and the awarding of bids to contractors from outside the region or state. A better forest product infrastructure in the region, coupled with a more predictable and consistent flow of local forest products to those local markets, would improve the economics of the local forest products industry and also provide further incentive for the continued and sustainable management of local forestlands.

Goal**: **Strengthen the regional forest product economy by creating a more consistent and predictable flow of forest products to local forest industries.

Recommendations:

- In conjunction with private foresters and the local forest product industry, support an expanded program of sustainable forest management on both public and private lands in the ecoregion that will produce a more consistent and predictable flow of forest products.
- Increase educational opportunities for private landowners regarding the Forest Stewardship Program, Chapter 61 and the Tree Farm program.
- Implement a pilot program on a state ownership using licensed private foresters to implement forest management plans.
- Market low-value forest products (i.e., biomass) using long-term harvesting contracts (e.g., 5-10 years) to supply a local biomass plant that provides heat and/or electricity to local municipalities, state facilities or private industry.
- Work with the forestry community to advocate for consideration of the local benefits of value-added forest products in future economic stimulus legislation.
- Educate the legislature and general public about the significant economic opportunities lost to Massachusetts when the value-added component of forest products is exported to other states or countries.

Issue 16: Undeveloped forestland provides a range of ecosystem services, including protecting drinking water supplies, moderating climate, filtering air pollutants, supporting biological diversity, providing open space and recreation, and attracting tourists. However, with recent increases in land values, Chapters 61 and 61A do not always provide enough incentive for keeping forestland undeveloped. Without adequate compensation, many landowners are removing their forestland from those programs and selling it for development.

Goal: Improve public understanding and appreciation for the multiple ecosystem values of undeveloped forests in this ecoregion so that better economic incentives to keep forests undeveloped can eventually be developed.

Recommendation:

- Convene a forest forum in the spring of 2004, with diverse representation from all parts of the forestry community, to identify opportunities to provide greater incentives for forestland protection.
- Work with both public and private partnerships to expand public education programs (including website information, publications, demonstration forests and other means) regarding the ecosystem values of undeveloped forests.
- Monitor efforts on the federal level to develop better valuations of the ecosystem services that undeveloped forests provide.

Issue 17: Cultural resources are fragile and non-renewable. Once destroyed, they are gone forever, giving them a value that is difficult to calculate. Plans and procedures are needed to locate and assess the condition of both historic and prehistoric cultural resources and to protect these unique and significant resources.

Goal: Assure the long-term protection of cultural resources in the LWP ecoregion.

Recommendations:

- Educate and train state land management staff in the identification and protection of cultural resources.
- Establish communication channels between land managers and DCR Cultural Resource Management staff for information sharing, and to assure compliance with state and federal laws, regulations and procedures.
- Incorporate applicable BMPs into forest management operations (see Appendix VI).

Issue 18: The ecoregional planning process provides a great opportunity for the public to have input into state policies and actions with regard to the forests of Massachusetts. Widespread and timely notification of the availability of ecoregion documents to a broad range of interested parties is needed.

Goal: Expand public input and awareness of the ecoregional planning process across the state.

Recommendations:

- Utilize the EOEA web site to post the schedule for ecoregion document development, and the draft and final ecoregional guidance documents.
- Utilize e-mail to expand the efficiency and scope of the notification process for ecoregional documents.
- Advertise the availability of ecoregion documents and comment periods in the Environmental Monitor.
- Maintain a regular mailing list for those without internet and email access.

IX. A Forest Management Framework for Massachusetts

The preceding section identifies a number of issues, goals and recommendations related to the management of both state and private forestland in Massachusetts and the LWP. However, management planning also occurs within a context of various regulatory, legislative, contractual and other standards and requirements. As a model of sustainable high quality forest stewardship, forest management on state-owned forestland must meet all of these standards and requirements. This section summarizes those requirements, and presents a general "framework" in which the management planning process for state properties will occur.

Overall, forest management on state-owned forestland meets a variety of objectives including the production of timber, fuelwood, and pulp; maintenance and creation of specific wildlife habitats; protection of drinking water supplies; and the provision of recreational opportunities. While the details of this management are best understood through the site specific management plans for each forest, the three land management divisions in Massachusetts conduct forest management within a broad, common framework that assures the sustainability of the practices and provides protection for sensitive resources that occur on all state-owned forestland. This framework includes both regulatory and silvicultural standards to which forest management on state-owned forestland in Massachusetts adheres. There are also common contractual procedures among the agencies – e.g., through which forest products are sold - and some similarities in the range of forest harvesting systems that are permitted to operate on Commonwealth properties.

Each of the EOEA divisions that manage forestland in Massachusetts employs professional forestry and natural resources staff who plan for and implement a wide range of silvicultural activities on these lands in order to meet the mandates and objectives of each agency and property. In general, those staff members are also responsible for developing management plans for those properties. Approximately 80% of state forestland in Massachusetts (not including most state parks and other recreational facilities) is considered to be under *active* management for a variety of resources, including wood products, wildlife habitat, and watershed protection. The remainder is often in a "protected" status, or considered to be under *passive* management – e.g., to establish late-successional forest and/or to conserve unique or sensitive species and habitats. Certain management activities occur across all state-owned forestland in Massachusetts, including boundary management, off-road vehicle management, and control of invasive, exotic species that degrade native forest ecosystems.

Regulatory Standards

All forest management on state lands is subject to a variety of Federal and Massachusetts laws and regulations. Many of these regulations are focused on preventing damage to water and wetland resources, while others protect endangered species and cultural resources, or prevent accidental fire damage. Some of these laws are listed below (NOTE: the full text of Massachusetts General Laws is available at *www.mass.gov/legis/legis.htm*).

1. Section 404 of the Clean Water Act of 1977 required the US Army Corps of Engineers to control any activities resulting in dredging or filling of waterways, a responsibility that has since been passed on to state agencies.
2. Section 319 of the Federal Clean Water Act Amendments of 1987 tasked the MA DEP with developing Best Management Practices to control non-point source pollution associated with timber harvesting.
3. Section 6217 of the Federal Coastal Zone Act Amendments of 1990 deals with non-point source pollution that affects coastal regions, requiring MA CZM to address any such problems associated with timber harvesting. All harvesting activities in the state are assumed to have the potential to affect the coastal zone, and are therefore subject to Section 6217 requirements.

4. The Source Water Assessment Program, required by the federal Safe Drinking Water Act Amendments of 1996, requires the MA DEP to assess potential threats to drinking water supplies and determine the susceptibility of supplies to these threats. Forest Operations is among the potential threats identified, though the focus of concerns was on "unregulated logging" (i.e., logging that falls outside the jurisdiction of the Forest Cutting Practices Act, described below).
5. MGL Chapter 48 (Fires, Fire Departments, and Fire Districts), especially Sections 16 thru 20 which deal with the handling of slash resulting from timber harvesting, to minimize fire danger.
6. MGL Chapter 30, Sections 61-62 (Environmental Impact of Projects, etc. Conducted by Agencies) and the Massachusetts Environmental Policy Act (MEPA) regulations (301 CMR 11.00) seek to limit or prevent negative impacts on the environment of the Commonwealth through a review procedure that requires impact reports for activities that exceed certain thresholds. Revisions to MEPA regulations, effective July 1, 1998 determined that MEPA review is not required for forest harvesting operations provided that a Chapter 132 Forest Cutting Plan has been filed, with a few exceptions. An Environmental Notification Form (ENF) and other MEPA review may be required for any non-bridged crossing 1,000 or fewer feet upstream of a public surface drinking water supply for the purpose of forest harvesting activities (bridged crossings do not trigger this review). While many projects that occur within a designated Area of Critical Environmental Concern require MEPA review, forest cutting that occurs in an ACEC under a Chapter 132 Cutting Plan is exempt from this review. Forest cutting undertaken *without* a Cutting Plan (e.g., because less than 25 thousand board feet or 50 cords are to be cut) may be subject to MEPA review if it alters an area in excess of 25 acres or occurs within an ACEC.
7. MGL Chapter 131, Section 40 (the Wetland Protection Act), which subjects any activity that would alter, dredge, fill, or otherwise harm wetlands to strict regulation.
8. MGL Chapter 132, Section 40-46 (the Forest Cutting Practices Act) and 304 CMR 11.00 require filing of a Cutting Plan for any timber harvest that exceeds 50 cords or 25 thousand board feet, except when clearing for public utilities or highways, maintenance cutting in pastures, cutting for the non-commercial use of the landowner, clearing land for cultivation or pasture, or change of use cutting (e.g. clearing house lots or mining gravel). (Note that all of these exceptions are subject to Chapter 131 and other environmental legislation). The act and regulations apply to harvesting on public or private lands, and address wetland protection, wildlife habitat and endangered species, and provide minimum environmental standards to which all regulated harvests must adhere. Chapter 132 also requires licensing of foresters and loggers who work in Massachusetts. If a Cutting Plan has been filed for a harvest, this harvest is exempt from the procedures required by Chapter 131 and is instead subject to wetland and environmental review by the DCR Service Forester assigned to the region.
9. 314 CMR 4.00 (Massachusetts Surface Water Quality Standards) provides additional protection for Outstanding Resource Waters, which are waters with exceptional socio-economic, recreational, ecological and/or aesthetic values (such as public drinking water sources). This protection extends to 304 CMR 11.00 cutting practices regulations, for instance by requiring that stream crossings by logging equipment within 1,000 feet upstream of a public water supply must use a temporary bridge or undergo MEPA review.
10. Federal and Massachusetts endangered species laws and regulations. MGL Chapter 131A (Massachusetts Endangered Species Act) prohibits the taking of any listed MA species. DCR Service Foresters are required to compare a proposed harvesting area on a Cutting Plan to the atlas of listed species habitats provided by the Natural Heritage program, and to contact NHESP for protection guidelines if these overlap.
11. Federal and Massachusetts laws for preservation of historic or prehistoric cultural resources do not apply until sites have been officially listed in the State or National Registers of Historic Places, or have been officially documented to contain prehistoric resources of significance. No such sites exist to date within Massachusetts state-owned forestland.

However, there are agency mandates for the protection of such sites, and minimum standards are evolving.

Among these and the many other laws and regulations that may impact forest management activities in Massachusetts, the Forest Cutting Practices Act and regulations are the most prominent set of rules regularly affecting forest management on state (and private) forestland. The Massachusetts standard upheld by this act is among the three or four most stringent in the nation, in the company of regulations in the states of Oregon, California, and Maryland. Listed below are some of the minimum environmental standards of these regulations that apply to forest management on all state-owned (as well as private) forests.

1. All trees to be cut (or, in some situations, to be left as seed sources) must be designated by marking, or by a detailed description in the forest cutting plan of the size, species, and quality of trees to be cut and the percentage of the basal area (stocking of trees) to be removed. Management objectives and silvicultural methods must be identified in the cutting plan.
2. Regeneration cuts (including selection system, shelterwood, seed tree, and clear cuts) require either the presence of 1,000 or more viable stems of regeneration per acre, the planting or direct seeding of this many trees, or verification that this condition will be met naturally within five years or fewer. The vast majority of management objectives are met through natural seeding. Intermediate cuts (thinnings) must meet minimum standards for residual stocking.
3. Seed tree and clear cut silvicultural systems also have additional requirements. Seed tree cuts are subject to specific requirements for the number and size of overstory trees left behind. The maximum clear cut opening size is ten acres unless the source of the regeneration is seeding from surrounding stands, in which case the maximum size is five acres. Clearcuts larger than these limits require an approved justification stating the ways in which environmental effects will be reduced, or environmental benefits enhanced by a larger opening size. As noted above, clearcuts in excess of 25 acres require the filing of an ENF.
4. Filter strips are required along all water bodies and certified vernal pools. The width of these strips is at least 50 feet, but increases with slope for streams wider than 25 feet, ponds 10 acres or greater, designated scenic rivers, and along Outstanding Resource Waters and their tributaries. Also, for all water bodies where the filter strip is 30% or greater in slope, the minimum width increases to 100 feet or to the point between 50 and 100 feet at which the slope drops to less than 30%. Clearcuts are not allowed within the filter strip, with some exceptions. Cutting in filter strips is limited to 50% of the basal area and the trees left behind must be healthy and well-distributed. Equipment is not allowed to operate within the filter strip except to access an approved stream crossing.
5. Roads must be designed, mapped, constructed, and maintained according to standards of drainage, erosion control, and slope limitations.
6. Landings must be placed at a sufficient distance from wetland and water resources, must be designed and built properly to limit erosion, must be kept free of trash, and must be stabilized at the end of use.
7. All regulated wetland resource areas must be accurately mapped in the cutting plan and logging is subject to a wide array of restrictions, including where, when, and how equipment is allowed to work on or near wetlands.
8. Stream and wetland crossings are required to meet minimum Best Management Practices (see Kittredge, D.B. and M. Parker, 1995. Massachusetts Forestry Best Management Practices Manual, available through DCR/DSPR Regional offices), with stronger restrictions for stream crossings within 1,000 feet upstream of a public water supply reservoir.

The above is by no means a comprehensive listing – these are simply examples to illustrate regulations for those unfamiliar with the Forest Cutting Practices Act. The full text of these regulations is available online at *www.mass.gov/dem/regs/304011b.htm*.

Management Planning

The development of site-specific forest or land management plans is a very important component of the overall management framework for state-owned forestland. The planning process starts with a review of the mandates or guiding principles that apply to a particular property. In some cases, these are legislative mandates, although more often they are in the form of agency or division mission statements and policies that are essentially interpretations of the legislation that created or guides the agency or division.

Good management requires good data, so inventorying and describing the natural and cultural resources of a property is an important component of management planning. Data on forest and other habitat or natural community types, rare species, geologic, soil and hydrologic features are all needed. Typically, remote sensing (e.g., aerial photo interpretation) provides general forest cover type information at the landscape level. However, whenever feasible and appropriate, the Natural Community Classification for Massachusetts (Swain and Kearsley, 2001) - which utilizes field assessments to provide more detailed vegetation descriptions than the more general forest cover types, and thus can be used to partition large, heterogeneous forest stands into more distinctive, homogeneous natural communities - will be used.

One of the more important parts of the land management plan is the section on goals and objectives, since these dictate why and how that land will be managed. While management goals are necessarily property-specific, they will relate back to those issues and goals identified in the appropriate ecoregion document as much as possible.

Areas that have been designated as forest reserves will be clearly described and mapped in each property management plan. Further guidance on identifying and designating reserves will become available in the near future (see Issue #2). Other areas to be protected (e.g., vernal pools, BioMap core habitats) or acquired (e.g., areas identified in the Statewide Land Conservation Plan and agency land committees) will also be identified and mapped in the management plan.

Public input into the management of state-owned forestland is very important, and public meetings and other opportunities for the public to actively engage in the planning process will be a component of each property's plan. Opportunities for periodic public reviews of the progress being made in implementing management plans will also be provided. Such reviews provide a means of accountability for the managers of these public resources.

Coordination with other agencies and divisions during the management planning process is also essential. For example, many state-owned forests are used heavily for recreation, so forestry activities must be planned with public safety, aesthetics and other potential conflicts in mind. Likewise, management of DSPR and DFW properties in the DWSP watersheds must be particularly mindful of water quality concerns.

Management plans include a long-term monitoring component so that conditions and changes in the forest, both due to natural and anthropogenic disturbances and processes, can be tracked over time. Further, state-owned forestland often provides excellent research opportunities. Especially as forest reserves "age," the opportunities to study ecological conditions in these areas will become increasingly significant.

Finally, good record-keeping is crucial in forest and land management programs. With recent advances in GIS and GPS technologies, record-keeping can incorporate enhanced mapping and geo-referencing of inventory and management information.

Silvicultural Standards

Silviculture involves the deliberate manipulation of forest stands to enhance the long-term attainment of a wide variety of goals – timber production, wildlife habitat creation and maintenance, aesthetic characteristics, recreational experiences, or drinking water supply protection, for example. Silviculture utilizes timber harvesting to deliberately adjust forest structure and composition to meet long term goals. In contrast, timber harvesting conducted in the absence of a long-range silvicultural plan focuses on short-term economic gains from the extraction of merchantable products. This is an important distinction. In Massachusetts, all timber harvesting on state-owned forestland is a component of long-range silvicultural planning and is designed and implemented in a manner that sustains the ability of that forest to meet long-range agency and division objectives while protecting natural and cultural resources on the site.

Timber harvesting that focuses on maximizing short-term revenue by cutting only the best, most valuable trees generally qualifies as "high-grading" of the forest. High-grading is not considered to be silviculture (because it degrades the long-term productivity of the forest), and therefore will not occur on state-owned forestland in Massachusetts. Similarly, **commercial clear-cutting**, in which all merchantable trees are stripped from a forest stand, leaving behind only trees with no value, is an extreme form of high-grading, is also not silviculture, and will not occur on state-owned forestland in Massachusetts. By contrast, a **silvicultural clear-cut** removes all trees from a designated area, reassigning all growing space to regeneration with high potential for vigorous growth and development. Silvicultural clear-cutting is a valuable silvicultural tool occasionally employed on state-owned forestland in Massachusetts.

Across the wide range of forest conditions and agency and division mandates within the state-owned forestland in Massachusetts, an equally wide range of silvicultural practices has been used and is proposed for use in the future. This range of practices is very generally described below, in the interest of providing readers with some idea of what they might encounter on a visit to one of the managed state-owned forest properties in Massachusetts. The range of practices is fully described in management planning documents prepared by each agency, and the specifics of any individual treatment are written in cutting plans that can best be described in detail by the professional forester in charge of the operation. Silvicultural treatments vary with the age and the stage of growth of the forest stand (an area of similar tree species and age composition and distinct from adjacent areas is a "stand"). In young stands, **intermediate treatments** are often employed to improve the growth and vigor of the most desirable trees for meeting stand objectives. When stand objectives call for the harvesting of mature overstory trees, this removal generally occurs in at least two stages: **regeneration establishment** and **regeneration release** cuttings, although regeneration may also be planned to *follow* the removal of the overstory, either through natural seeding or through artificial planting, in which case the harvest would be more appropriately termed, simply, an overstory removal. In selection systems, both intermediate and regeneration components are done within the same entry in order to create or perpetuate a stand with three or more age classes. These treatments and some other general silvicultural principles are described below, although no attempt has been made to provide a comprehensive description of silviculture on state-owned forestland in Massachusetts.

Intermediate treatments: These treatments include a wide variety of thinnings, generally referred to as improvement thinnings. The objective of the thinning may be to simply reduce the number of trees per acre, or may also seek to reduce the number of poorly-formed or low-vigor trees in order to shift the growing resources to trees of better quality. Thinnings also sometimes focus on shifting the species composition, for instance by removing poor quality red maple and birch to encourage the growth of oak trees in a mixed hardwood stand, in order to realize the substantial habitat benefit from acorns, and the economic value of oak timber.

Regeneration establishment *(a.k.a. preparatory cutting):* A common objective of silviculture is to assure the presence of desirable and vigorous seedlings and saplings in the understory, in order to set the stage for the next forest when the current stand is harvested. The forester carefully manipulates light conditions through thinnings and may also call for loggers to deliberately "scarify" the accumulated organic litter in order to encourage the success of a particular species. Some species are much more difficult to establish than others and may require **enrichment plantings** to ensure their presence in the future stand. For example, supplementing the sometimes inadequate natural regeneration of oaks by planting oak seedlings, or planting white pine on a oak-dominated upland in order to reduce the future stand's susceptibility to gypsy moth damage.

Regeneration release*:* The successful establishment of regeneration can take many years. Soon after it is established, however, regeneration will stagnate and eventually may perish if it is not released from the shade of overstory trees so it can grow and develop. This requires the removal of additional overstory trees, either individually or in groups ranging from $1/10^{th}$ acre to multiple acres in size. These cuttings release the understory seedlings and saplings to become either a new stand or a new age-class within an uneven-aged stand (see next topic).

Even-aged and uneven-aged silvicultural methods: While any forest is likely to include trees of many ages, individual stands of trees are either even-aged (all of about the same age, or two distinct age classes) or uneven-aged (at least three distinct age "classes" within the stand). Natural disturbances can create either condition, depending on the size of the disturbance. For instance, a catastrophic wind event might blow over the entire overstory of a stand, so that the stand that eventually takes its place is started at about the same time (within about ten years of the initiating disturbance). On the other hand, small-scale disturbances such as the death of individual trees and small groups of trees due to pests or disease leave behind a stand with many different age groups or "cohorts." The vast majority of Massachusetts forests, state and private, are even-aged, as a result of farm abandonment at the turn of the century and large-scale disturbances such as the hurricane of 1938.

Professional foresters working on state-owned properties in Massachusetts conduct silvicultural practices that reflect the range of naturally-occurring conditions. **Single tree and small group selection** methods remove the overstory from only a portion of the stand, resulting in a stand that eventually contains at least three distinct age classes, an uneven-aged stand. Silvicultural clearcutting removes the overstory all at once in circumstances in which regeneration of desired tree species can best be accomplished with a single, full overstory removal cut. The **shelterwood system** removes the forest canopy in two or three stages over approximately 20-30 years. Both clearcutting and shelterwood cutting result in an even-aged new stand.

It is common on state-owned forests for managers to apply varieties of the standard silvicultural practices described above. Examples include “irregular” shelterwood cutting (which can be seen on both DWSP and DFW lands), and “aggregate retention cutting” (which can be seen on DFW lands). Irregular shelterwood typically involves the retention of some overstory trees into or beyond the next rotation in order to provide aesthetic benefits, as well as structural diversity and associated wildlife habitat benefits in managed forests. Aggregate retention cutting typically involves the retention of clusters of overstory trees throughout what would otherwise be a clearcut, in order to maintain cool, moist microclimates within the cut area. These areas help conserve various salamanders and other wildlife species with limited dispersal capabilities and hasten the re-establishment of continuous forest canopy across the site.

The choice of silvicultural method used to treat a stand depends on an almost endless combination of variables. If the principal objective for managing the stand is to realize the highest possible long term value from harvesting wood products, intermediate and regeneration treatments will be organized around market values, the productive capacity of the site ("site index"), and the opportunities to grow and regenerate specific species. For instance, the highly-valued oak species in our forests are best established in the shade of a shelterwood preparatory cut, but may eventually

require large openings to provide enough light for oak to compete successfully with other species. If stand objectives included the perpetuation of a stand of sugar maple, this shade-tolerant species is best regenerated using single tree and small group selection methods in an uneven-aged system. The scarcity of early-successional habitats (seedlings and saplings) identified elsewhere in this document may recommend that some relatively large full overstory removals occur on state-owned forest properties in Massachusetts where creating a diversity of forested habitats for wildlife is a guiding objective. The desire to encourage exceptionally large diameter trees in some state-owned stands may argue for simply doing nothing, or might be best met through gradual, continuous individual tree and small group selection cutting.

Rotations and cutting cycles: It is probably common for a visitor who encounters a timber harvest on Massachusetts state-owned forestland to wonder how frequently harvesting will take place in this area. Once again, a very wide range of variables dictate this schedule, but there are some general guidelines that affect all Massachusetts state-owned forest properties. In long-range silvicultural planning, two general principles apply to the timing of operations: rotation and cutting cycle. The **rotation** is the expected maximum age to which the trees in a given stand will be grown before they are harvested. There are methods for calculating the point at which a tree of any given species slows in value growth to an economically unacceptable pace, at which point a strictly financial analysis would recommend that the tree be harvested (and replaced with a younger one). The age of this *financial* maturity might be used as the rotation point of the stand. So if a pine stand is being grown to produce wood and revenue, it might be grown for just 70 to 80 years, even though the point of *biological* maturity (the age at which the tree would begin to die of natural causes) would occur considerably later. On state-owned lands, the rotation age is often set beyond the age of financial maturity in order to realize non-commodity attributes of the forest such as wildlife habitat or aesthetic or recreational values. In these cases, an **extended rotation** is applied, which falls somewhere between the points of financial and biological maturity. Extended rotations will also occur in stands that are very low priority for active management, or when the primary objective in a stand is to create late-seral forest conditions.

As it matures toward the rotation age, the stand might be thinned several times for reasons described above. The frequency with which the stand is entered to conduct intermediate treatments is the **cutting cycle**. On actively managed Massachusetts state-owned forests, cutting cycles are commonly in the 15 to 50 year range, although there are exceptions. For instance, as a white pine stand approaches the desired rotation age, it may be regenerated through a series of preparation and removal cuts that take place within 5 to 10 years of each other, and an intensively managed uneven-aged stand may require entry every 10 years. These are the exceptions. In general, a visitor can expect that actively managed properties will be treated only once every 15 to 50 years.

Salvage cutting: When a stand is badly damaged by insects, disease, fire, wind, ice, or snow, foresters must decide whether it is more desirable to salvage the damaged timber or to let the stand recover gradually without intervention. These disturbances are generally unplanned disruptions of long-range objectives, and salvage harvesting is only silviculture to the extent that it prepares the stand to recover from the disturbance. These disturbances can eliminate some silvicultural options, for instance when a wind event removes a shelterwood overstory and allows shade intolerant species to compete with the desired regeneration species. Where disturbances present a public safety hazard or involve valuable timber, there may be a strong incentive to initiate a salvage operation. There are areas and circumstances where salvage is not desirable, for instance when risks associated with the salvage effort exceed the potential gains from salvaging (for example, when the damaged stand is on a steep slope or on wet soils adjacent to water resources).

In summary, the **common components of silviculture across the state** include, among others:

1. All timber harvesting on Massachusetts state-owned forests is a component of long-range silvicultural planning and is designed and implemented in a manner that sustains the ability

of that forest to meet long-range agency objectives while protecting natural and cultural resources on the site.

2. Some timber harvesting practices are not components of a long-range, silvicultural approach and will not occur on state lands. These include high-grading (cutting only the best, most valuable trees) and commercial clear-cutting (removing all merchantable trees but leaving all unmerchantable trees standing).
3. Silviculture on state (and private) lands generally progresses through three broad types of treatment; intermediate treatments (thinnings), regeneration establishment, and regeneration release cuttings. These cuttings support either even-aged or uneven-aged systems of silviculture, or systems that bridge the two.
4. While rotations (the target maximum age to which a stand will be grown) are generally 80 to 150 years or more on state lands (longer for stands aimed at producing late-seral stage conditions), cutting cycles (the frequency with which a stand is treated) will range from 15 to 50 years.
5. Salvaging of damaged forest stands may or may not occur on state lands, depending on the objectives for the stand, the accessibility and sensitivity of the damaged area, and the value of the damaged timber.

Contractual Standards and Cutting Plans

In Massachusetts, when the plan for a given stand within state-owned forestland calls for a harvesting operation to take place, a licensed professional forester reviews the stand, marks (commonly with blue paint) the trees to be cut, measures both their diameter at breast height and height in log length to estimate their merchantable volume. Rarely, a harvest area is so homogeneous or of such low value that the trees are not individually marked. For instance, in a heavy overstory removal cut in a stand of very poor timber quality "pasture pine" or in a final removal cut in a uniform red pine plantation, some trees may be marked for retention while all *un*-marked trees are cut. In these cases, the boundaries are carefully marked and the total area carefully measured, but volumes to be cut are estimated from a series of representative plots within the total harvest area.

Timber harvesting that takes place on state-owned forestland in Massachusetts is subject to Commonwealth contract and bidding procedures and to the Forest Cutting Practices Act and regulations. Once the wood to be sold has been marked or otherwise identified, a timber sale is described using the agency's timber harvest permit or contract format. These documents include estimates of volumes to be sold, by product (sawlogs, firewood, pulp, poles) and by species. They also may include specifications for equipment to be used (e.g., a limitation on ground pressure or width, or a requirement that a particular piece of equipment be used because of site limitations). The timing of the operation is specified, and the procedures for bidding and paying for the lot are detailed. Lots are then advertised through newspaper announcements, the internet, and/or a mailing to a list of prospective bidders. The advertisement includes a date when the lot will be shown to prospective bidders. At this showing, the forester walks the lot and describes where roads, stream crossings, and landings will be placed and a wide variety of other conditions specific to the lot. A date is established by which all interested bidders must submit a sealed bid. At a specified time and date, these bids are opened. Generally, the highest bid from a contractor whose equipment meets the standards is accepted. However, the agency reserves the right to reject any and all bids, for instance if the prices bid are below the minimum expected.

While DSPR, DWSP, and DFW permit timber harvesting under agency contracts or permits to harvest, there are common features in these documents, listed below:

1. A non-refundable deposit is required at the time of bidding, to secure the bidders intent to follow through with harvesting.
2. In addition, a performance bond must be posted, which is only returned once the logger has completed the harvest and followed procedures to "put the lot to bed" (e.g. by cleaning and

seeding landings, placing water bars as needed on skid trails, and removing temporary stream crossings). The performance bond also provides significant leverage during the operation. If a logging contractor fails to meet performance standards, for instance by excessively damaging unmarked trees, he may sacrifice his bond and may ultimately be removed from the list of potential bidders for future agency timber sales if the problems continue.

3. Harvesting contractors/permittees are required to hold the Commonwealth and its employees harmless from and against any claims arising from their activities during the course of the harvesting operation.
4. Payments for lots are generally required either in lump sum before the lot is started or in a series of payments as fractions of the lot are started (usually when the total bid is large).
5. A specific timeframe is designated during which the lot must be completed, although also included is the option of a time extension for specific reasons. Failure to complete the lot in the specified timeframe can result in the operator losing both the performance bond and rights to timber remaining on the lot.
6. Provisions are made for the forester in charge to temporarily suspend harvesting activities due, for instance, to soil conditions (the arrival of mud season), extreme fire danger, or wildlife considerations (breeding seasons).
7. Haul roads, skid trails, and landings are addressed in the plan. Generally these are either laid out in advance by the forester, or subject to forester approval.
8. Utilization standards are specified. These may include a tip diameter to which all products must be utilized and removed from the site, and on some contracts also specify a minimum amount of coarse woody debris that must be left on site at the conclusion of the lot.
9. The danger of fire is covered in the permit/contract, with specifications for preventing its ignition and spread. These include requirements for the treatment of slash and general recommendations for handling flammable materials.
10. Treatment of slash is specified. At a minimum, this treatment must follow the Slash Law, MGL Chapter 48, section 16.
11. The possibility of oil spills (motor oil, diesel fuel, hydraulic oil, bar and chain oil and gas) is addressed. Permits/contracts require that operators carry a "spill kit" that includes sufficient oil-absorbing cloth to protect soil and water resources in the event of a spill. Specifications are included for the handling of hazardous materials, including a statement of liability for the clean-up of accidental spills.
12. In addition to hazardous materials, requirements are included for the removal of all waste materials, including garbage, trash, litter, discarded equipment or parts, and all other waste. For areas with sensitive water resources, specifications are also included for toilet facilities and the treatment of human waste.

In addition to the timber sale contract, a cutting plan is completed to meet the requirements of Chapter 132. This plan includes a locus map and a detailed map of the harvest area including roads, landings, wetlands, and wetland and stream crossings. Details of the cutting plan are partially listed under the section above on Regulatory Standards. The operator is identified on the cutting plan, including his/her Timber Harvester License number. The silvicultural methods are identified and described in detail where necessary and the volumes of products by species that are being sold are listed. This cutting plan is submitted to the DCR Service Forester responsible for the area in which the harvest will take place. The landowner is required to notify the Conservation Commission in the associated town, and that Commission has ten days in which to comment if they so desire. Abutters are also notified. The Service Forester compares the harvest area to the areas identified by Natural Heritage as being critical habitats for listed Massachusetts species. If the harvest overlaps a critical habitat, then Natural Heritage is required to either indicate that there is no conflict or to work with the forester to determine limitations (for instance, staying out of a turtle breeding habitat during breeding season). Once these procedures have been met, the harvesting contractor may set up to begin cutting the lot, under forester supervision.

Timber Harvesting Systems

The business and science of harvesting timber has changed dramatically in the past 40-50 years. At the turn of the last century, horses and oxen were still the principal means of pulling logs from the forest. This eventually gave way to small crawler tractors pulling a sled for loading logs, and then to center-articulated log skidders with cable winches. These skidders grew in power and operator safety features, but remained the standard for many years. Cable winches were supplemented with grapples that enabled an operator to pick up a load of logs without leaving the safety of the cab, but the initial felling, limbing, and bucking of logs continued to require a chainsaw operator exposed to the worst dangers of logging. In the past couple of decades, this has changed as well, with the arrival of sophisticated harvesting and processing machines. The simplest of these is the mechanical feller, which allows the operator to remain in the protective cab while felling the tree with a machine-mounted saw or shear. More sophisticated machines, feller/processors, first grab the tree, then cut it free from the stump, lay it down at the desired angle, and then delimb, buck, and pile it in place. These machines are equipped with heated/air conditioned enclosed cabs, sophisticated controls, and computers. Toothed rollers move the log through the delimbing arms and also allow the computer to track lengths and diameters for accurate and efficient tracking of production. To complete the harvest, cut-to-length products are removed using forwarders, a machine that loads logs onto a bunk or trailer and carries them out of the woods. At the time of this report, mechanized harvesting is growing rapidly in popularity among Massachusetts timber harvesters, although chainsaw felling and skidders are still common. The move to full mechanization can require equipment purchases of $500,000 to $1 million per business, which is a strong deterrent for small operators, despite the dramatic increase in production and safety.

Along with the increased size and complexity of harvesting equipment have come some increased risks to forest resources, requiring greater care by the operator. Although wider, high floatation tires reduce ground pressure, they add width to the machines, which reduces their ability to work in tight stands being partially harvested. While mechanical harvesters can provide surgical precision in felling operations, they must travel to within reach of every tree. Even with wider tires, a fully loaded forwarder produces ground pressures that can exceed those of a typical loaded skidder. On the other hand, forwarders eliminate the damage to residual trees associated with dragging logs behind a skidder, and allow the wood to be removed to a much smaller and cleaner landing area as all the bucking to length is completed in the woods. Perhaps the greatest concern associated with all harvesting machines is the volume of hydraulic fluid they carry on board to operate the sophisticated clamping, cutting, lifting, and processing capabilities of the machines. At a minimum, these have required the development of related Best Management Practices to reduce the likelihood of a damaging spill. As mentioned above, state timber sales increasingly require operators of logging machinery to carry special oil-absorbent padding and other materials (a "spill kit") to quickly mitigate the potential adverse impacts of any accidental fluid leak. With careful operation and monitoring, this equipment in total can result in great improvements in safety and productivity, and can also reduce the net impact of the harvesting operation on other resources. Operated poorly and without supervision, the opposite is true.

Glossary

Aesthetics - forest value, rooted in beauty and visual appreciation, affording inspiration, contributing to the arts, and providing a special quality of life.

Age Class – 1) one of the intervals into which the age of trees is placed for classification or use. 2) a distinct aggregation of trees originating from a single natural event or regeneration activity, or a grouping of trees, e.g., 10-year age class, as used in inventory or management.

Allowable Harvest – the calculation of the amount of forest products that may be harvested, annually or periodically, from a specified area over a stated period, in accordance with the objectives of management.

Alluvial soil – a soil developing from recently deposited water-borne sediments and exhibiting essentially no horizon development or modification of the recently deposited materials.

Anadromous – migrating up rivers from the sea to breed in fresh water.

Anthropogenic – of human origin or influence.

Aquifer – a saturated, permeable geologic unit of sediment or rock that can transmit significant quantities of water under ordinary hydraulic gradients.

Area of Critical Environmental Concern (ACEC) – area within the Commonwealth of Massachusetts where unique clusters of natural and human resource values exist, and which is worthy of a high level of concern and protection (from 301 CMR 12.00)

Aspect - the orientation of a slope with respect to the compass; the direction toward which a slope faces; north facing slopes are generally cooler than south facing slopes.

Basal area (BA) - a measurement of the cross-sectional area of a tree trunk in square feet at breast height. Basal area of a forest stand is the sum of the basal areas of the individual trees, and is reported as BA per acre.

Biodiversity (Biological Diversity) – 1) the variety and abundance of life forms, processes, functions, and structures of plants, animals, and other living organisms, including the relative complexity of species, communities, gene pools, and ecosystems at spatial scales ranging from local through regional to global. 2) an index of richness in a community, ecosystem, or landscape and the relative abundance of these species

Biological legacy - an organism, a reproductive portion of an organism, or a biologically derived structure or pattern inherited from a previous ecosystem. Note: biological legacies often include large trees, snags, and down logs left after harvesting to provide refugia and to structurally enrich the new forest stand.

Biological maturity - the point in the life cycle of a tree at which there is no net biomass accumulation; the stage before decline when annual growth is offset by breakage and decay.

Biological Monitoring - repeated sampling of plant and animal species occurrence and structural habitat characteristics to track baseline conditions and/or to determine pre- and post-treatment conditions in order to evaluate the effectiveness of management activities relative to established goals and objectives.

Biomass – 1) *ecology* - the total dry organic matter at a given time of living organisms of one or more species per unit area (species biomass) or of all the species in the community (community

biomass). 2) the living or dead weight of organic matter in a tree, stand, or forest in units such as living or dead weight, wet or dry weight, ash-free weight, etc. 3) *harvesting* - the wood product obtained (usually) from in-woods chipping of all or some portion of trees including limbs, tops, and unmerchantable stems, usually for energy production.

Board foot - a unit of wood 1 inch thick, 12 inches long, and 12 inches wide. One board foot contains 144 cubic inches of wood.

Bole - the main trunk of a tree.

Browse - portions of woody plants including twigs, shoots, and leaves used as food by such animals as deer.

Buffer Strip – area along a road where intensity of cutting is restricted to maintain a forested appearance and an attractive landscape; harvesting in buffer areas is limited to light cutting where 50% or less of the basal area is removed at any one time (as per 304 CMR 11.00).

C.F.I. (**C**ontinuous **F**orest **I**nventory) - a sampling method using permanent plots that are visited periodically to inventory large forest properties. Its purpose is to ascertain the condition of the forest as regards health, growth, and other ecosystem dynamics.

Canopy - the upper level of a forest, consisting of branches and leaves of taller trees. A canopy is complete (or has 100 percent cover) if the ground is completely .hidden when viewed from above the trees.

Classified Lands – lands classified under M.G.L. Chapters: 61- CLASSIFICATION AND TAXATION OF FORESTLANDS AND FOREST PRODUCTS, 61A - ASSESSMENT AND TAXATION OF AGRICULTURAL AND HORTICULTURAL LAND, and 61B - CLASSIFICATION AND TAXATION OF RECREATIONAL LAND

Coarse Woody Debris – dead woody material (e.g., dead boles, limbs, and large root masses) on the ground in the forest stands or in streams – *note:* the type and size of material designated as coarse woody debris varies among classification systems.

Community - a collection of living organisms in a defined area that function together in an organized system through which energy, nutrients, and water cycle.

Conservation - the wise use and management of natural resources.

Coppice - (even-aged or uneven-aged) any type of cutting in which dependence is placed mainly on vegetative reproduction.

Core Habitats - the most viable sites presently identified in Massachusetts by the Natural Heritage and Endangered Species Program to maintain populations of rare species and natural communities.

Corridor - a strip or block of habitat connecting otherwise isolated units of suitable habitats that allow the dispersal of organisms and the consequent mixing of genes. A corridor is also beneficial to plant populations that have been isolated due to fragmentation**.**

Cover Type – the plant species forming a plurality of composition across a given area, e.g., oak-hickory, northern hardwood, maple-birch.

Crown class - an evaluation of an individual tree's crown in relation to its position in the canopy and the amount of full sunlight it receives. The four recognized categories are: dominant (D), codominant (C), intermediate (I), and overtopped or suppressed (S).

D.B.H. (**D**iameter at **B**reast **H**eight) - the diameter of a standing tree measured at 4.5' above the ground.

Daylight – *verb*; to cut vegetation adjacent to a road or other open area to increase the amount of sunlight reaching its surface.

Den Tree – living hollow trees that are used as homes by mammals or birds.

Diameter Class (Size Class) – any of the intervals into which a range of diameters of tree stems or logs may be divided for classification and use – e.g., 0 – 3.5" DBH = seedling – sapling, 3.5" – 9.5" DBH = pole timber, 9.6" – 14.5" DBH = small sawtimber, > 14.6" + DBH = large sawtimber.

Diameter-limit cut - a timber harvesting treatment in which all trees over a specified diameter may be cut. Diameter-limit cuts often result in high-grading.

Disturbance - a natural or human-induced environmental change that alters one or more of the floral, faunal, and microbial communities within an ecosystem. Timber harvesting is the most common human disturbance. Windstorms and fire are examples of natural disturbance.

Duff – the partially decomposed organic material of the forest floor beneath the litter of freshly fallen twigs, needles, and leaves.

Ecological Reference Condition - a condition that represents the state of an ecosystem at a particular time in history, deemed by society to be of particular interest. In Massachusetts, such reference conditions include, but are not limited to, the field and pasture ecosystem at the height of agricultural development in the 1800s, the oak-chestnut woodland ecosystem maintained by tribes of woodland Indians prior to European arrival and settlement, or the extensive beech-maple and spruce-fir forests prior to Indian arrival. Due to changes in climate or pathogens, some reference conditions are impossible to duplicate exactly today (such as the chestnut component of oak-chestnut woodlands, or the extent of the spruce-fir forests prior to Indian arrival) and others are completely out of reach (such as the tundra and taiga conditions following the retreat of the last glacier from this region).

Ecologically Viable - able to maintain process, function and structure over time.

Ecology - the study of interactions between living organisms and their environment.

Ecosystem - a natural unit comprised of living organisms and their interactions with their environment, including the circulation, transformation, and accumulation of energy and matter.

Ecotype - a genetic subdivision of a species resulting from the selective action of a particular environment and showing adaptation to that environment. Ecotypes may be geographic, climatic, elevational, or soil related. Red maples and northern red oaks are both adapted to moist soils, but can also be found on drier sites where the genetic difference is their enhanced ability to retain water.

Edge - the boundary between open land and woodland or between any two distinct ecological communities. This transition area between environments provides valuable wildlife habitat for some species, but can be problematic for sensitive species, due to increased predation and parasitism.

Endangered Species (E) - native species that are in danger of extinction throughout all or part of their range, or which are in danger of extirpation from Massachusetts, as documented by biological research and inventory.

Even-aged stand - a group of trees that do not differ in age by more than 10 to 20 years or by 20 percent of the rotation age.

Extended rotation - a rotation longer than necessary to grow timber crops to financial maturity or size; generally used to provide habitat or nontimber values.

Featured Resource – the resource that is the primary focus of management activities.

Filter Strip – an area of forestland, adjoining the bank of a water body, where no more than 50% of the basal area can be cut at any one time (as per 304 CMR 11.00).

Ford – a stream crossing using a stable stream bottom as the roadbed.

Forest interior dependent species - animal species that depend upon extensive areas of continuous, unbroken forest habitat to live and reproduce, and are susceptible to higher rates of predation and population decline when interior forest habitat is fragmented or disturbed.

Forest types - associations of tree species that commonly occur because of similar ecological requirements. Massachusetts three major forest types are northern hardwoods, oak/hickory, white pine and oak/pine.

Fragmentation - the segmentation of a large tract or contiguous tracts of forest to smaller patches, often isolated from each other by nonforest habitat. Fragmentation often results from the collective impact of residential and commercial development, highway and utility construction, and other piecemeal land use changes.

Girdling – a method of killing unwanted trees by cutting through the living tissues around the bole. Girdling can be used instead of cutting to prevent felling damage to nearby trees. Girdled trees can provide cavities and dead wood for wildlife and insects.

Grade – the angle of an inclined surface as expressed in terms of percent slope: vertical rise per 100' of horizontal run.

Growing Stock – all the trees growing in the forest or in a specified part of it, usually commercial species, meeting specified standards of size, quality, and vigor, and generally expressed in terms of number or volume.

Habitat - the geographically defined area where environmental conditions (e.g., climate, topography, etc.) meet the life needs (e.g., food, shelter, etc.) of an organism, population, or community.

Herbaceous – any seed-producing plant that does not develop persistent woody tissue above ground.

High Risk - stands which will not survive the next decade or in the same period, due to decay, insect or disease mortality or other factors, will suffer a net volume or value loss.

High-grading - the removal of the most commercially valuable trees (high-grade trees), often leaving a residual stand composed of trees of poor condition or species composition – note high grading may have both genetic implications (i.e., dysgenic effects) and long-term economic or stand health implications.

Historic vernacular landscapes - those landscapes that reflect past human behavior by containing remnants of past spatial organization, land use, circulation, vegetation, structures, and objects; and

in which the physical, biological, and cultural features reflect the customs and everyday lives of people; i.e., historic farmsteads with remnant orchards, roads, stone walls, gardens, archaeological sites.

Horizontal structure - the spatial arrangement of plant communities; a complex horizontal structure is characterized by diverse plant communities within a given geographic unit.

Immature - stands which have not reached maturity.

Improvement Cutting – a cutting made in a stand past the sapling stage for the purpose of improving composition and quality by removing trees of undesirable species, form or condition from the main canopy.

Interior Forest - forest >300 m from a fragmenting edge, such as a road or powerline.

Intermediate Cuttings – operations conducted in a stand during its development from regeneration stage to maturity. These are done to improve the quality of the existing stand, increase its growth and provide for earlier financial returns, without any effort directed at regeneration.

Landing – any place where round timber is assembled for further transport, commonly with a change in method; generally, a cleared area where log trucks are loaded.

Landscape – a special mosaic of several ecosystems, landforms, and plant communities across a defined area irrespective of ownership or other artificial boundaries and repeated in similar form throughout.

Legacy Trees - individual trees retained after harvesting, or that have survived natural disturbances, that provide a biological legacy (see Biological Legacy). These trees are often much bigger and older than the average trees in the forest, and their physical structure is much more complex than that of their younger neighbors.

Management plan - a document prepared by natural resource professionals to guide and direct the use and management of a forest property. It consists of inventory data and prescribed activities designed to meet ownership objectives.

Mast – seed produced by woody-stemmed, perennial plants, generally referring to soft (fruit) or hard (nut) mast.

Mature - stands which have reached the stage where the main purpose for which they were maintained has been fulfilled - either having produced the best supply of specified products or earned a specified rate of interest.

Merchantable – of trees, crops or stands, of a size, quality and condition suitable for marketing under given economic conditions even if so situated as not to be immediately accessible for logging. Syn., operable.

Mesic – sites or habitats characterized by intermediate moisture conditions, i.e., neither decidedly wet nor dry.

Multiple use and value - a conceptual basis for managing a forest area to yield more than one use or value simultaneously. Common uses and values include aesthetics, water, wildlife, recreation, and timber.

Natural Community - recurrent assemblages of plants, animals, and associated ecological processes.

Niche - the physical and functional location of an organism within an ecosystem; where a living organism is found and what it does there.

Old Growth Forest - an area of contiguous forest that: (1) shows no evidence of significant human, post-European disturbance that originated on site; (2) has a significant component of older trees that are greater than 50 percent of the maximum longevity for the particular species; (3) is at least five acres in size; and (4) has either: (i) the capacity for self-perpetuation; or (ii) the characteristics of a forest which are indicative of an old growth forest. (Note: This definition comes from proposed legislation in the Massachusetts legislature)

Old Growth Stand – a stand that has been formally designated as an old growth stand. These areas must meet a preponderance of the following four criteria: (1) be of a size that is large enough to be self sustaining; (2) show no evidence of significant post-European disturbance; (3) have a component of trees that are greater than 50% of the maximum longevity for that species; and (4) be self-perpetuating.

Outstanding Resource Water (ORW) – as defined in the Massachusetts Water Quality Standards (314 CMR 4.04) - refers to waters with exceptional socio-economic, recreational, ecological and/or aesthetic values. To protect these values, potentially harmful activities are sometimes restricted in the drainage areas that supply these waters, thus the ORW *watershed areas* are often delineated as well.

Patch - a small area of a particular ecological community surrounded by distinctly different ecological communities, such as a forest stand surrounded by agricultural lands or a small opening surrounded by forestland.

Permeability – the ease with which gases, liquids, or plant roots penetrate or pass through a bulk mass or layer of soil

Poletimber - trees greater than 4.9" dbh and less than sawtimber size.

Population - a group of individuals of one plant or animal taxon (species, subspecies, or variety).

Preservation - a management philosophy or goal which seeks to protect indigenous ecosystem structure, function, and integrity from human impacts. Management activities are generally excluded from "preserved" forests.

Primary Forests - areas that have continually supported forest growth throughout the time of European settlement. Primary forest in Massachusetts has usually been cut repeatedly over time (especially for fuelwood in colonial times), but was never converted to agricultural use such as pasture or cropland, and thus retains a more intact soil micro-climate compared to second-growth forests that occur on abandoned agricultural lands.

Rare species - species that exist only in one or a few restricted geographic areas or habitats or occur in low numbers over a relatively broad area; also, plant and animal species listed by the Commonwealth of Massachusetts as 'Endangered', 'Threatened', or 'Special Concern'.

Recreation – outdoor recreation is generally considered to be of two types. *Extensive recreation* is that which occurs throughout a large area and is not confined to a specific place or developed facility e.g., hunting, fishing, hiking, horseback riding, snowmobiling, cross-country skiing, etc. Syn, dispersed. *Intensive recreation* includes high density recreational activities that take place at a developed facility e.g., camp and picnic grounds and swimming beaches.

Regeneration – the renewal of a tree crop, whether by natural or artificial means - may be broken down into those treatments that produce stands originating from seed (high forest) or from vegetative regeneration (coppice or sprouts) and create even-aged or uneven-aged stands. Syn. reproduction.

Release - removal of overtopping trees to allow understory or overtopped trees to grow in response to increased light.

Residual stand - trees remaining following any cutting operation.

Restoration – *ecology:* the process of returning ecosystems or habitats to their original structure and species composition.

Riparian – related to or located in conjunction with a wetland, on the bank of a river or stream but also at the edge of a lake or tidewater – note the riparian area significantly influences, and is significantly influenced by, the neighboring body of water.

Riparian Forest - forest occurring in conjunction with a stream, river, wetland, pond, or lake.

Rotation – the planned number of years between the formation or regeneration of a crop or stand and its final cutting at a specified stage of maturity.

Salvage Cutting – the removal of dead trees or trees damaged or dying because of injurious agents other than competition; usually designed to recover economic value that would otherwise be lost.

Sanitation Cutting – a cutting involving the elimination of trees that have been attacked or appear in imminent danger of attack by dangerous insects or fungi in order to prevent the pests from spreading to other trees.

Sapling - a tree greater than 1" dbh and less than 4.9" dbh.

Sawtimber - a tree greater than 9.0" dbh (hardwoods) or 11.0" dbh (softwoods) having at least 8' of usable length and less than 50% cull.

Seedling - a young tree, less than sapling size of seed origin.

Seed-trees – individual trees left after a harvest operation to provide a seed source for forest regeneration.

Selection (uneven-aged management) - removal of mature timber, usually the oldest and largest trees, either as single scattered individuals or in small groups at relatively short intervals, repeated indefinitely, whereby the continuous establishment of reproduction is encouraged and an uneven-aged stand is maintained.

Seral Stages (**Seres**)- the stages of ecological succession of a plant community; the characteristic sequence of biotic communities that successfully occupy and replace each other, altering in the process some components of the physical environment over time.

Shade-tolerant – having the capacity to compete for survival under shaded conditions.

Shelterwood (even-aged management) **-** removal of the old stand in a series of cuttings that extend over a relatively short portion of the rotation, by means of which the establishment of essentially even-aged reproduction under the partial shelter of seed trees is encouraged.

Silvicultural System – a planned series of treatments for tending, harvesting, and re-establishing a stand – *note* the system name is based on the number of age classes (coppice, even-aged, two-aged, uneven-aged) or the regeneration method (clear-cutting, seed tree, shelterwood, selection, coppice, coppice with reserves) used.

Silviculture – the art and science of controlling the establishment, composition, growth, health, and quality of forests and woodlands to meet the diverse needs and values of landowners and society on a sustainable basis.

Site quality - the inherent productive capacity of a specific location (site) in the forest affected by available growth factors (light, heat, water, nutrients, anchorage); often expressed as tree height at a given age.

Site - the combination of biotic, climatic, topographic, and soil conditions of an area; the environment at a location.

Size Classes – intervals of tree diameters used to classify timber. Size classes typically include: seedling/sapling, poletimber, and sawtimber.

Slash – tops, branches, slabs, sawdust or debris resulting from logging or land clearing operations.

Snag – a standing dead tree, greater than 20' tall, which has decayed to the point where most of its limbs have fallen; if less than 20' tall it is referred to as a *stub*.

Special Concern (SC) species - native species that have been documented by biological research or inventory to have suffered a decline that could threaten the species if allowed to continue unchecked, or which occur in such small numbers or with such restricted distribution or specialized habitat requirements that they could easily become threatened within Massachusetts.

Species - a subordinate classification to a genus; a group of reproductively isolated organisms that have common characteristics, such as eastern white pine or white-tailed deer.

Stand – 1) *ecology:* a contiguous group of similar plants. 2) *silviculture:* a contiguous group of trees sufficiently uniform in age-class distribution, composition, and structure, and growing on a site of sufficiently uniform quality, to be a distinguishable unit..

Stand Condition – the condition of a stand described as one of the following: non-stocked, high risk, sparse, low quality, mature, immature, all aged, or in process of regeneration.

Stewardship - the wise management and use of forest resources to ensure their health and productivity for the future.

Stocking – the degree of occupancy of an area by trees.

Succession (or Ecological Succession) - an orderly, directional and therefore predictable process of development that involves changes in species structure and community processes over time. It results from a modification of the physical environment by the community and culminates in a stabilized ecosystem in which maximum biomass and symbiotic functions are maintained.

Sustainable management - the stewardship and use of forests and forestlands in such a way and at such a rate that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfill relevant ecological, economic and social functions at local, national, and global levels, and that does not cause damage to other ecosystems.

Sustained yield - historically, a timber management concept in which the volume of wood removed is equal to growth within the total forest. The concept is applicable to non-timber forest values as well.

T.S.I. (Timber Stand Improvement) - a term comprising all intermediate cuttings made to improve the composition, constitution, condition and increment of a timber stand. The practice may be *commercial* (yielding net revenues), *pre-commercial* or *non-commercial*; the cost of accomplishing TSI work generally exceeds the value of the products removed.

Talus Slope - an uneven landform typically covered by coarse rock debris forming a more or less continuous layer, usually at the base of a steep slope. Talus slopes may or may not be covered by duff and litter, and thus may or may not support tree growth and other vegetation.

Thinning - a cutting whose purpose is to control the growth of stands by adjusting stand density.

Threatened Species (T) - native species that are likely to become endangered in the foreseeable future, or which are declining or rare as determined by biological research and inventory.

Tolerance - a characteristic of trees that describes the relative ability to thrive with respect to the growth factors (light, heat, water nutrients, anchorage). For instance, a "shade tolerant" species may thrive at low light levels.

Understory - the smaller vegetation (shrubs, seedlings, saplings, small trees) within a forest stand, occupying the vertical zone between the overstory and the herbaceous plants of the forest floor.

Uneven-aged stand - a group of trees of various ages and sizes growing together on a site.

Value added – 1) converting outputs into products of greater value; 2) increasing the economic value of an agricultural commodity through changes in genetics, processing or diversification; 3) the process of increasing the consumer appeal of a commodity.

Vernal Pools - a class of wetland characterized by small, shallow, temporary pools of fresh water present in spring and fall, which typically do not support fish but are very important breeding grounds for many species of amphibians. Some species are totally dependent upon such ponds; examples are spring peepers and mole salamanders.

Vertical structure - the arrangement of plants in a given community from the ground (herbaceous and woody shrubs) into the main forest canopy; a complex vertical structure is characterized by lush undergrowth and successive layers of woody vegetation extending into the crowns of dominant and codominant trees.

Wetlands – transitional areas between aquatic and terrestrial ecosystems that are inundated or saturated for periods long enough to produce hydric soils and support hydrophytic vegetation – Massachusetts defines "wetlands" according to M.G.L. Chapter 131, Sec. 40 "Wetlands Protection Act" and 310 C.M.R. 10.00 "Wetland Protection Regulations."

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